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May 1989
T^3B: Field Test New Energy Planning Procedures

US Army Corps of Engineers
Construction Engineering Research Laboratory

TECHNOLOGY TRANSFER TEST BED PROGRAM

Field Demonstration of the Energy Planning Module's Energy Conservation Options Proposed for the DD Form 1391 Processor

by
Dahtzen Chu

Seven U.S. Army Corps of Engineers (USACE) Districts evaluated a list of 62 energy conservation options (ECOs) that belong to a pilot Energy Planning Module developed by the U.S. Army Construction Engineering Research Laboratory (USACERL). The module was intended to be incorporated into the DD Form 1391 Processor to recommend ECOs for a new project based on the facility's space characteristics and climatic data. The objective of this test was to determine the validity of these ECOs for USACE designs.

The test participants' responses to the concept of an Energy Planning Module were mostly negative. The rationale was that energy conservation guidance for new designs is already provided by either the contracted designer or the District. Only one respondent specifically recommended placing ECOs into the DD 1391. All others indicated that the module was either superfluous or would hinder the design process.

Based on the responses received from this demonstration, continuation of research on the concept of an Energy Planning Module for the DD Form 1391 Processor is not recommended. Nevertheless, there is a need to provide appropriate ECOs at some point in the building delivery process. Studies are underway to evaluate these ECOs and include them in standard design criteria such as guide specifications and technical manuals. These mechanisms should provide an effective way to incorporate ECOs without subjecting designers to repetitive, tedious examinations.

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TECHNOLOGY TRANSFER TEST BED PROGRAM

FINDINGS AND RECOMMENDATIONS OF TEST/DEMONSTRATION

WORKUNIT NO./TITLE OF TEST: T^3B, "Field Test New Energy Planning Procedures"

PERFORMING LABORATORY: USACERL

PRODUCT/SYSTEM: Energy Conservation Options for an Energy Planning Module of the DD 1391 Processor

PERFORMING TEST SITES: The following Districts: Fort Worth, TX, Louisville, KY, Mobile, AL, Omaha, NE, Sacramento, CA, Savanna, GA, and Seattle, WA.

DESCRIPTION/OBJECTIVE OF TEST/DEMONSTRATION:

Seven U.S. Army Corps of Engineers (USACE) Districts evaluated a list of 62 energy conservation options (ECOs) that belong to a pilot Energy Planning Module. This module was intended to be incorporated into the DD Form 1391 Processor to recommend ECOs for a new project based on the facility's space characteristics and climatic data. The objective of this test was to determine the validity and usefulness of these ECOs for USACE designs.

RESULTS OF TEST DEMONSTRATION:

The test participants' responses to the concept of an Energy Planning Module were mostly negative. The rationale was that energy conservation guidance for new designs is already provided by either the contractor or the District. Only one respondent specifically recommended placing ECOs into the 1391 Processor. All others indicated that the module was either superfluous or would hinder the design process. In addition, it was found that almost half of the ECOs would seldom apply due to different facility types and climates. The small number of facilities (37) considered in the evaluation also made it difficult to draw definitive conclusions as to which ECOs are ideal for which facility types and climates.

RECOMMENDATION FOR PRODUCT/SYSTEM:

Based on the responses received in this demonstration, continuation of research on the concept of an Energy Planning Module is not recommended. However, there is still a need to provide appropriate ECOs at some point in the building design process. Studies are underway to evaluate these ECOs and include them in the standard design criteria such as guide specifications and technical manuals. These mechanisms should provide an effective way to incorporate ECOs without subjecting designers to repetitive, tedious examinations.

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Seven U.S. Army Corps of Engineers (USACE) Districts evaluated a list of 62 energy conservation options (ECOs), ~~that belong to~~ a pilot Energy Planning Module developed by the U.S. Army Construction Engineering Research Laboratory (USACERL). The module was intended to be incorporated into the DD Form 1391 Processor to recommend ECOs for a new project based on the facility's space characteristics and climatic data. The objective of this test was to determine the validity of these ECOs for USACE designs.

The test participants' responses to the concept of an Energy Planning Module were mostly negative. The rationale was that energy conservation guidance for new designs is

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already provided by either the contracted designer or the District. Only one respondent specifically recommended placing ECOs into the DD 1391. All others indicated that the module was either superfluous or would hinder the design process.

The results of the ECO evaluation suggested that almost half of these ECOs would seldom be considered during design. The reason stated was that consideration of ECOs is often dependent on the facility type and local climatic conditions. The small number (37) of facilities examined in the evaluations also made it difficult to draw definitive conclusions as to which ECOs are ideal for which facility types and/or climates.

This Technology Transfer Test Bed (T^3B) demonstration has indicated that, from these designers' perspective, the Energy Planning Module does not satisfy a current need in the design process. Although there is some support for incorporating ECOs into the DD 1391 to the predesign phases, it is only minimal.

The lack of enthusiasm for the Energy Planning Module appears to be based on the perception that it provides additional energy guidance that is not needed by designers. However, it should be noted that the module's intended purpose was to promote energy conservation by giving planners and programmers more input in the early stages of the Military Construction, Army (MCA) process.

Based on the responses received from this demonstration, continuation of research on the concept of an Energy Planning Module for the DD Form 1391 Processor is not recommended. Nevertheless, there is a need to provide appropriate ECOs at some point in the building delivery process. Studies are underway to evaluate these ECOs and include them in standard design criteria such as guide specifications and technical manuals. These mechanisms should provide an effective way to incorporate ECOs without subjecting designers to repetitive, tedious examinations.

FOREWORD

This work was performed for the Directorate of Engineering and Construction, Headquarters, U.S. Army Corps of Engineers (HQUSACE), as a project in the Technology Transfer Test Bed (T^3B) Program under the Corps of Engineers National Energy Team (CENET). The T^3B Work Unit is entitled "Field Test New Energy Planning Procedures." The research and development for this test were performed for HQUSACE under Project 4A162781AT45, "Energy and Energy Conservation"; Work Unit 008, "Energy Conscious Planning and Programming for New Facilities." Mr. J. McCarty, CEEC-EE, was the HQUSACE Technical Monitor.

The field test was administered by the Energy Systems Division (ES), U.S. Army Construction Engineering Research Laboratory (USACERL). Dr. G. R. Williamson is Chief, ES. Seven U.S. Army Corps of Engineers Districts participated in the test: Fort Worth, TX, Louisville, KY, Mobile, AL, Omaha, NE, Sacramento, CA, Savannah, GA, and Seattle, WA.

Appreciation is expressed to all personnel from the District offices who participated in the test. The technical editor for this report was Dana Finney, USACERL Information Management Office.

COL Carl O. Magnell is Commander and Director of USACERL, and Dr. L. R. Shaffer is Technical Director.

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CONTENTS

FIELD DEMONSTRATION OF THE ENERGY PLANNING MODULE'S ENERGY CONSERVATION OPTIONS PROPOSED FOR THE DD FORM 1391 PROCESSOR

1 INTRODUCTION

Background

The U.S. Army Construction Engineering Research Laboratory (USACERL) has been investigating methods of increasing the awareness of energy conservation during the early planning stages of a new facility.[1] One facet of this research has involved studying the possibility of incorporating an energy planning module into the automated DD Form 1391 Processor, which is part of the revised Integrated Facilities System (IFS-M). The DD Form 1391 is required to be prepared early in the Military Construction, Army (MCA) process. It serves as a detailed summary of project specifications and cost estimates, and various energy sources are considered for usage. Information from the 1391 is used to establish energy consumption goals for an entire installation. The purpose of the energy planning module would be to give planners, programmers, and designers more exposure to energy conservation options before and during the initial stages of design.

A pilot energy planning module has recently been developed by USACERL. This module is intended to recommend a number of energy conservation options for a project based on its space characteristics and climatic data as provided by the planner or designer. Ideally, because the data provided to the module are specific to a project, the options produced by the module should be only those most appropriate. By raising the awareness of energy conservation design guidance during preparation of the DD Form 1391--before design actually begins--it is anticipated that a more energy-efficient facility will be produced.

USACERL developed the energy options based on the previous work in energy-efficient facilities. However, before further development of this module for incorporation into the DD Form 1391 Processor, the appropriateness of the energy conservation options to the Army require evaluation by U.S. Army Corps of Engineers (USACE) designers working in the field. This type of evaluation will ensure that the energy planning module is applicable in actual use and that it achieves its intended objectives. Feedback from the field will be used to refine and enhance the module to result in a useful product.

A field test for the energy module has been funded under the FY87 Technology Transfer Test Bed (T^3B) program. USACE initiated the T^3B program to identify, produce, and demonstrate technologies meeting the users' needs. Participation in the T^3B program is voluntary, and participants are reimbursed for their time and effort.

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[1] D. Leverenz, et al., *Energy Impact Analysis of the Military Construction-Army Building Delivery Systems*, Technical Report E-188/ADA135277 (U.S. Army Construction Engineering Research Laboratory [USACERL], October 1983); D. Chu, L. Krajnovich, and L. Lawrie, *Improved Planning and Programming for Energy-Efficient New Army Facilities*, Technical Report E-89/02/ADA202086 (USACERL, November 1988).

Objective

The objective of this research was to determine the validity of the energy conservation options of the pilot energy planning module through a field demonstration as part of the T^3B program.

Approach

Eight USACE Districts agreed to participate in the T^3B evaluation. USACERL developed a test plan to ensure consistency in the evaluation (Appendix A). The designers at each District were asked to review a list of specific energy conservation options and apply them to facility types located in their general climatic region. Since these options can be used for both in-house and contracted designs, the designers were asked for feedback on the suitability of the options to these types of design work. Finally, the designers were asked for any additions or deletions to the list of options. Of the eight Districts participating in the T^3B test, seven provided responses of varying length and detail which are presented verbatim in Appendix B.

Scope

This report covers only the field test to validate 62 energy conservation options. Research and development of the energy module and its options are covered in USACERL Technical Report E-89/02.[2]

[2]D. Chu, L. Krajnovich, and L. Lawrie.

2 DESCRIPTION OF THE T^3B TEST

Each participating District received a T^3B test evaluation sheet (see Appendix A). They were also provided with a list of definitions of the energy conservation options contained within the evaluation sheet. The Districts were then requested to select project planning and design personnel to complete the sheets and return them to USACERL. The respondents were to choose several facility types and determine the applicability of the energy conservation options to each.

The evaluation sheet is divided into three sections. The first section asks the respondents general questions about the projects they selected for evaluation. The second section requests that they review the list of energy conservation options as specifically applied to a particular project. The actual number of projects to be evaluated was left for respondents to decide based on the amount of time they had available (this number ranged from 0 to 10). The last section asks about the overall usefulness of the pilot energy planning module, and also contains space for any miscellaneous comments or suggestions the respondents might have.

Responses from the Districts varied, with some providing more detailed comments than others. Also, one District was unable to complete the evaluation and returned the funds. At each of five Districts, the evaluations were done primarily by one mechanical engineer, or two at most. The remaining two Districts did the evaluations using teams composed of various disciplines (architectural, electrical, mechanical, and site planning). Chapter 3 summarizes the results of the T^3B test.

3 RESULTS AND ANALYSIS

The first set of questions requested the following information on the background of the projects:

1. Are these projects typical for your District or were they examples specially created to study the options? All buildings selected by each District for evaluation were typical projects for that District. Most of the Districts tried to include a variety of facility types from different installations. One-third of these were U.S. Air Force projects.

2. Are the designs normally done in-house or contracted? The projects selected were designed both in-house and by outside architectural/engineering (A/E) firms. Two Districts stated that most of their designs are contracted. This may or may not be the case for the other Districts.

3. If the designs are contracted, are energy conservation options supplied by the A/E firm or by in-house designers? Both the A/E firm and in-house designers were said to supply energy conservation options. For designs that are contracted, the Districts also provide energy conservation guidance to the A/Es through design instructions. These instructions can be quite detailed, providing a high level of guidance to the designer. Installations that have their own requirements said they supply them through the DD 1391 and Project Development Brochures (PDBs).

4. How important a role do the DD 1391 and PDBs have during the development of a project? The DD 1391 and the PDBs were reported to have a very important role in development of a project by defining its design criteria and scope. These documents, however, do not seem to have much influence on providing energy conservation guidance. It was noted that existing references to energy in the DD 1391 and PDBs do not place a strong emphasis on energy. However, the designers did not recommend using them to mandate the inclusion of energy conservation options in the design. The reason given was that including certain energy conservation options in these documents can result in other potentially relevant, but not listed, options being ignored. Less effort may also be directed toward the energy requirements of a District's design instructions if the A/E perceives that the options included in the DD 1391 or PDB are the only energy considerations that need be addressed. Some responses stated that the installation can request specific design criteria at the predesign conference.

The second set of questions asked the respondents how relevant the energy conservation options are compared with their current design practices:

1. How comfortable were you with the options provided? Would they be considered by designers in the developmental phase? Most respondents were satisfied with the set of energy conservation options. The general impression was that all relevant options probably would be considered by good designers, although there were some reservations. The main concern was that there may not be a need for all of the options to be formally considered during a project's design; one respondent felt that most of the options were not of the type normally considered in design. It was noted that an experienced designer may be able to "mentally select or reject some [options] without having to do a study." Another concern was that designers in different disciplines (mechanical, architectural, civil) may not be familiar with all of the options.

2. If the set of energy conservation options were kept up-to-date, what techniques are necessary to encourage full use of these options during the design process? Most responses indicated that the best way to encourage the use of energy conservation options during the design process would be to include them in the District's A/E design guide or manual. If specific options are desired, they can be listed in the DD 1391. Making these options "available" instead of "mandatory" to designers would be more feasible because designers would not then have to spend excessive time evaluating all of the options individually.

3. Are there any constraints on the options that should be noted to future designers? What improvements should be made? Respondents stated that all options used should follow good design practice and sound engineering judgment, comply with current Federal laws and codes, and provide customer satisfaction. Guidance that can suggest when options should be considered would be helpful, but including the options in the DD 1391 and PDBs may increase design costs simply because they would become additional line items.

The last set of questions asked for recommendations on future testing or broader applications:

1. Do you feel it was worthwhile for you to study these options? Two respondents apparently misunderstood the question, believing it asked them if studying all options for a project was worthwhile. Except for these two, all other responses were "yes."

2. Would you participate in future field tests of these options? Most responses were positive, although the extent of participation was said to depend on their workload and funding availability.

In the second section of the T^3B test, the respondents were asked to review 62 energy conservation options with respect to facilities located within their climatic region. The purpose of this review was to determine how appropriate these options would be if they were incorporated into an automated energy planning module.

Each respondent was requested to choose several projects typical of those built by the District. Each project selected was to be identified by name, location, square footage, function, and major space types (Appendix C). Participants were asked if the set of climatic data used to select the options is adequate. Then they were asked to review the list of options. All options that would normally be considered for that project were to be identified and ranked with a value of 1 to 10, with 10 being the most important. They were also asked to identify the options not normally considered for that project.

The results of the evaluations were quite variable. Five Districts provided evaluations, with the number of projects evaluated per District ranging from 2 to 10. Altogether, 37 projects were evaluated (Table 1). There were a few projects for which the respondents would have liked to have had USACERL include some additional climatic criteria, but for the most part, there were no disagreements with the climatic data used. The way the options were ranked for each project also varied among Districts. Ideally, the most appropriate options should be given a high value of 10. Less appropriate ones would receive lower values down to 1. This rating did not proceed as intended. Some respondents ranked all of the options, including those not normally considered, whereas others ranked only the specific options considered. In one case, the selected options also were not ranked.

Table 1

Ranking of Options for Each Facility Evaluated

Yes	No	Strategy Description	Rank
28	0	S51 Efficient fixtures and lamps	9.4628
28	0	S50 Minimize light fixtures	9.0028
28	0	S34 Zoned air handling	8.9326
26	2	S37 Insulate ducts and pipes	8.7529
29	0	S18 Infiltration control	8.6626
26	2	S36 Minimize resistance in duct and pipe	8.6425
25	1	S59 Optimum water pipe and tank insulation	8.4226
26	2	S52 Efficient artificial lights compat. w/daylight	8.3224
24	2	S61 Reduced water supply temperature	8.1520
20	9	S17 Optimize insulation level	7.3120
20	9	S16 Minimize glass area	6.8621
21	8	S30 Decreased supply and makeup air	6.7222
22	7	S1 Building shape and orientation	6.5219
19	10	S13 Zoned lighting system	6.4519
19	10	S15 Double glazing	6.4120
20	9	S33 Task specific temperature and humidity level	6.0020
20	8	S53 Timers for lights	5.7918
18	1	S7 Daylighting	5.6914
14	12	S62 Flow restrictions & water conserving fixtures	5.5818
18	11	S27 Airlock entries	5.3817
17	11	S42 Dry-bulb temperature economy cooling	5.3220
20	9	S24 Thermal breaks	5.0714
14	15	S25 Vented roof or plenum	5.0317
17	12	S11 Skylights	4.9716
16	13	S9 Fixed exterior shading	4.8317
17	12	S29 Variable air volume system	4.8116
16	11	S60 Energy monitor. and control system (EMCS)	4.7816
16	13	S12 Natural ventilation	4.7216
16	12	S41 Exterior vented heat-producing equipment	4.5012
12	17	S19 Vapor barrier	4.4112
12	16	S48 Humidification of supply air	4.2916
16	13	S3 Landscaping	4.1413
13	16	S14 Task specific illumination level and equipment	3.9314
14	14	S54 Daylight responsive lighting controls	3.8212
12	17	S8 Increased surface reflectance	3.14 9
9	17	S58 Point of use water heaters	2.9610
10	18	S38 Variable water flow rates	2.86 9
9	20	S21 Air destratification	2.5510
10	19	S2 Earth berming	2.48
7	21	S45 Heat recovery chiller	2.43
8	22	S26 Group heat producing equipment	2.40
7	21	S35 Spot cooling and heating	2.2911
11	18	S10 Seasonal window shading	2.17
7	21	S55 Motion sensitive lighting control	2.04
6	23	S6 Heat absorbing glazing	1.90
7	22	S20 Air barrier curtains	1.86

Table 1 (Cont'd)

Yes	No	Strategy Description	Rank
3	23	S57 Heat recovery	1.69
5	24	S49 Runaround coil distribution system	1.48
4	25	S31 Air-to-air heat exchanger	1.37
1	25	S56 Heat pump water heater	1.27
5	24	S28 Duty cycling	1.24
3	25	S47 Preheat boiler inlet water w/flue gas	1.21
2	26	S46 Monitor oxygen in boiler combustion air	1.14
3	25	S39 Direct evaporative cooling	1.11
2	27	S32 Latent heat exchange pipe system	1.00
3	25	S40 Indirect evaporative cooling	0.93
2	27	S4 Direct gain glazing (direct solar gain)	0.83
1	27	S43 Reuse of exhaust air	0.82
1	28	S22 Increased ceiling height	0.69
0	29	S5 Indirect gain glazing (indirect solar gain)	0.55
0	28	S44 Electronic filter	0.54
0	29	S23 Moveable insulation	0.52

Due to the varied responses, interpreting the results was difficult. For instance, one respondent may have considered an option viable, but gave it a low value of 1. A different respondent may not have considered that same option, but still gave it a value of 1. In some cases, options that were not considered were not given any value. Finally, one respondent apparently misunderstood the convention and ranked only the top 10 options on a scale of 1 to 10 in descending order. It was hypothesized that one way to avoid these inconsistencies would be to average all of the values given to each option. This would assign every option a single value by which its importance relative to the others could be gauged. At this point, it was decided to arbitrarily give options with no values a value of 0 so they could be included in the averaging. (The options ranked by the respondent who misunderstood the question were not included since the scale used was completely different and not all considered options were given values.)

Table 1 shows the options ranked using the procedure described above. These options can be divided into roughly three groups. The first group contains nine options that were consistently rated higher than the others. None of these had more than two "No" responses, and their average value ranged from 8.15 to 9.46. Almost all options in the second group had more "Yes" than "No" responses. Most of these values were 4.00 or higher. The last group consists of options with more "No" than "Yes" replies. Most values in this group were below 3.00, and seven of these were below 1.00. With the exception of the first group, it was difficult to make a definite determination as to appropriateness of the remaining options.

Options in the second group can probably be included for consideration most of the time since the majority of responses toward them was positive. The last group contains options that, based on the responses, should be considered only in certain situations. A few options apparently should never be considered.

Determining how appropriate each option is for a specific facility type was not possible in most cases because of the relatively small number of projects reviewed. Also, the comments received with the evaluation and rankings are limited in usefulness since they numbered too few. Usually, each option had comments from only one or two Districts. Also, most of these came from three Districts, and their respondents' opinions may or may not be shared by others. The comments do provide an indication, however, of which options are not applicable for certain climatic conditions or facility types (Appendix D).

After examining the values assigned to the options and reviewing the associated comments, it appears that many of the options are not widely considered during design. There could be many reasons for this situation--e.g., economics, reliability (in terms of consistent performance), and local climate. The few that are considered probably include those which are always automatically investigated during design. Further study is needed to determine why designers do not consider a wider range of energy options.

The last section of the T^3B test evaluation sheet asked about the pilot energy planning module in general, including miscellaneous comments.

1. The eventual goal is to integrate an energy planning module into the DD 1391 Processor. The module would list options to be considered in the design of a new facility. What should be the maximum number of options to be supplied by the module? No common number was given here. The respondents indicated that options should: be kept to a minimum; include only practical options; and list only the options important to a facility type in a specific climatic region. Economics was a major concern since evaluating more options would expend more time and funds. The actual number of options studied may depend more on the designer's prerogative or facility type than on information provided by the DD 1391 Processor. Also, it may not be a good practice to restrict the designer to considering only a set number of options to study.

2. Miscellaneous comments, suggestions, etc. Only two comments were received. The main concern expressed was that any kind of design guidance used or provided should be general enough to give designers maximum flexibility. In addition, the guidance should not be overly complicated for DD 1391 preparers to use.

4 CONCLUSIONS AND RECOMMENDATIONS

As part of the FY87 T^3B Program, USACERL has field-tested the 62 energy conservation options proposed for the energy planning module of the DD 1391 Processor. The test attempted to validate the applicability of energy conservative design options. Eight USACE Districts received the test plan and were asked to comment. Seven Districts responded; one was unable to complete the test.

In determining which energy conservation options should be included in the module, no firm conclusions can be reached from the evaluations and comments received in the T^3B test. As discussed in Chapter 3, such conclusions are not feasible due to the limited number of comments and the small sample size of the test. It may be possible, however, to remove a few of the options from the module based on negative comments about their usefulness. For example, the options in the first group appear to always be required in existing design guidance. Thus, including them in the module would provide no additional benefit to designers. The options in the second and third groups are the ones that may be overlooked most often during design. However, some of these options are more appropriate for specific climates or facility types than others. A module that could account for these differences would offer designers an appropriate range of options for consideration during planning or initial design, depending on their unique needs. At the very least, it would give designers a good starting point for a design that addresses energy conservation.

Before an energy planning module can be implemented, an accurate determination must be made as to which options are most appropriate for certain climates and/or facility types. This task will not be easy because of the great number of combinations possible. The need to keep the module up to date must also be considered. As energy conservation technology changes, these changes must be incorporated into the module, and obsolete options removed. Another concern is the timespan between entering ECOs into the DD 1391 Processor and actually initiating the design process. This could be several years. In the interim, conditions may have changed so as to necessitate deletion or addition of options.

Responses from the participants indicate that many of them do not see the need for an energy planning module in the DD 1391 Processor. They fear that adding more energy guidance to the DD 1391 may actually hinder, rather than help, designers by giving them more design options to consider.

It must be noted, however, that the intent of the energy planning module is not to require a designer to consider only a set number of design options, but to promote early attention to energy conservation in planning, programming, and design. From the comments returned, it appears that designers receive adequate energy guidance from existing District design guides and manuals, but the same may not be true for planners and programmers. Only designers were asked to participate in the T^3B test and it is possible that the results would have been different if planners and programmers were also included. Because planners and programmers are the persons involved with project initiation, they also need to know which energy conservation options are applicable. They should be able to suggest certain options to consider, and then later, designers can decide if these merit further investigation. The suggestions should not be taken as being all-inclusive and mandatory; they are not intended to restrict designers' initiatives, but to give planners and programmers more input into the design process.

Based on the results of this demonstration, continuation of research on the energy planning module is not recommended. However, there is still a need to provide appropriate energy conservation options at some point in the building delivery process without subjecting the options to repetitive, superfluous examination. Studies are underway to evaluate these options and include them in standard design criteria such as guide specifications and technical manuals.

APPENDIX A:

ENERGY PLANNING AND PROGRAMMING TEST PLAN, FY87*

Purpose

The U.S. Army Construction Engineering Research Laboratory (USACERL) has been conducting research in the area of determining energy conservation options available at the early stages of planning a facility. The results of this research will place into the DD 1391 document general ideas for conserving energy in the facility during concept and final design.

Before these ideas can be implemented, the recommendations to be placed into the planning documentation must be validated by USACE designers.

District designers will be asked to review a list of specific energy conservation options for facility types in their general climatic region. These options belong to an Energy Planning Module currently under development by USACERL. The purpose of the Energy Planning Module is to provide a list of options to planners and designers of new facilities. Selection of the most appropriate options by the module would be based on a facility's space characteristics and the local climate. As these options will be used for both in-house and contracted designs, the designers will be asked for general ideas of measuring whether the options have been properly studied in contracted or in-house designs. In addition, the designers will be asked for any additions or deletions to the list of options.

*This is the actual test plan as distributed to participants.

Results of Evaluation

The evaluation should be presented in report form and include all of the evaluation sheets filled out by the designers. Additional information to be covered in the report should include, but should not be limited to, the following topics and answers to questions:

1. Background on the projects selected for study:

a. Are these projects typical for your District or were they examples specially created to study the options?

b. Are the designs normally done in-house or contracted?

c. If the designs are contracted, are energy conservation options supplied by the A/E firm or by in-house designers?

d. How important a role do the DD 1391 and PDBs play during the development of a project? If possible, submit examples of the DD 1391 and PDBs for past projects.

2. Perceived relevance of the options compared with current design practice:

a. How comfortable were you with the options provided? Would they be considered during design by designers?

b. If the set of energy conservation options were kept up-to-date, what techniques are necessary to encourage full use of these options during the design process?

c. Are there any constraints on the options that should be noted for future users? What improvements should be made?

3. Recommendations for further testing or broader application:

a. Do you feel that it was worthwhile for you to study these options?

b. Would you participate in future field tests of these options?

Energy Planning and Programming Evaluation

(Attach separate sheets as necessary)

1. User: Date:

2. Project, location, total square footage.

3. Describe project's function (list category code) and its 3 major space types (provide square footage for each).

4. The Energy Planning Module currently under development bases its selection of energy conservation options on a facility's space types and the climatic conditions at its location. The following climatic data are used:

- Heating degree days
- Diurnal range in heating season
- Average wind speed in heating season
- Cooling degree days
- Average enthalpy in cooling season
- Maximum daytime temperature in cooling season
- Diurnal range in cooling season
- Average wind speed in cooling season.

Are these sufficient? If not, identify additional climatic data requirements.

5. Based on the answers to questions 2 and 3 above, which of the following energy conservation options would be studied during the facility's design? (Circle all applicable ones.)

SITE STRATEGIES

1) Building shape and orientation
2) Earth berming
3) Landscaping

SOLAR STRATEGIES

4) Direct gain glazing (direct solar gain)
5) Indirect gain glazing (indirect solar gain)
6) Heat-absorbent glazing
7) Daylighting
8) Increased surface reflectance
9) Fixed exterior shading
10) Seasonal window shading
11) Skylights

ARCHITECTURAL AND STRUCTURAL STRATEGIES

12) Natural ventilation
13) Zoned lighting system
14) Task-specific illumination level and equipment
15) Double glazing
16) Minimized glass area
17) Optimized insulation level
18) Infiltration control
19) Vapor barrier
20) Air barrier curtains
21) Air destratification
22) Increased ceiling height
23) Movable insulation
24) Thermal breaks
25) Vented roof or plenum
26) Group heat-producing equipment
27) Airlock entries

MECHANICAL STRATEGIES

28) Duty cycling
29) Variable air volume system
30) Decreased supply and makeup air
31) Air-to-air heat exchanger
32) Latent heat exchange pipe system
33) Task-specific temperature, humidity level
34) Zoned air handling
35) Spot cooling and heating
36) Minimized resistance in duct and pipe
37) Insulated ducts and pipes
38) Variable water flow rates
39) Direct evaporative cooling
40) Indirect evaporative cooling
41) Exterior venting heat-producing equipment
42) Dry-bulb temperature economy cooling
43) Reuse of exhaust air

44) Electronic filter
45) Heat recovery chiller
46) Oxygen in boiler combustion air monitored
47) Boiler inlet water preheated with flue gas
48) Humidification of supply air
49) Runaround coil distribution system

ELECTRICAL STRATEGIES

50) Minimized light fixtures
51) Efficient fixtures and lamps
52) Efficient artificial lights compatible with daylight
53) Timers for lights
54) Daylight-responsive lighting controls
55) Motion-sensitive lighting control

UTILITY STRATEGIES

56) Heat pump water heater
57) Heat recovery
58) Point of use water heaters
59) Optimum water pipe and tank insulation
60) Energy Monitoring and Control System (EMCS)
61) Reduced water supply temperature
62) Flow restrictions and water-conserving fixtures

6. On a scale of 1 to 10, rank the options from question 5 in order of importance to the facility. (1=least, 10=most)

7. Which options are inappropriate for the facility as a whole or for specific space types? Explain why.

Energy Planning and Programming Evaluation

General Comments

(Attach separate sheets as necessary)

1. An eventual goal is to integrate the Energy Planning Module into the DD 1391 Processor. The module will provide a list of options to be considered in the design of a new facility. What should be the maximum number of options to be supplied by the module?

2. Miscellaneous comments, suggestions, etc.

APPENDIX B:

VERBATIM PARTICIPANT COMMENTS FROM THE T^3B TEST

For this presentation, responding Districts are abbreviated as follows:

SWF - Fort Worth, TX

ORL - Louisville, KY

SAM - Mobile, AL

MRO - Omaha, NE

SPK - Sacramento, CA

SAS - Savannah, GA

NPS - Seattle, WA

SECTION 1

1. BACKGROUND ON THE PROJECTS SELECTED FOR STUDY

   a. Are these typical projects for your District or were they examples specially created to study the options?

      MRO (elec)--Yes [typical].
      MRO (mech)--Yes [typical].

      NPS--Yes. The District has recently designed several administrative type facilities and reserve centers.

      ORL--Typical projects. Specially selected.

      SAM--The projects selected for study are typical for Mobile District. They were selected to show a cross-section of types of projects and locations that Mobile District handles, except Air Force projects were not included because the Air Force publishes its own guidance on energy conservation. Eliminating Air Force projects eliminated any consideration of Florida's climatic conditions.

      SAS--Actual typical projects were picked at random. The selection included two contract designs and one in-house design. Two were Army projects and one was an Air Force project.

      SWF--The projects selected are typical recent projects which represented a variety of the facility types designed by the Fort Worth District.

   b. Are the designs normally done in-house or contracted?

      MRO (elec)--A/E and in-house depending on workload.

MRO (mech)--Both ways.

NPS--Both in-house and contract A/E services are used by the District.

ORL--Both, most contracted.

SAM--The majority of the designs are done by A/E contract.

SAS--Both methods are routinely used.

SWF--The designs of these projects are normally done both by in-house force and contracted to A/E.

c. If the designs are contracted, are energy conservation options supplied by the A/E firm or by in-house designers?

MRO (elec)--In-house designers with A/E manual and design instructions.

MRO (mech)--Usually by the A/E.

NPS--Both, plus the standard Seattle District A/E design instructions.

ORL--Supplied by A/E firm or design criteria.

SAM--For contracted designs, the A/E is required to produce the most energy-efficient design possible consistent with mission requirements and budget for the project. Mobile District incorporates into each A/E contract our *Design Manual for Architect/Engineer Services*. Chapter 18 of this manual is entitled "Energy and Economic Studies"; it includes comprehensive instructions to the A/E and incorporates applicable references. Except in the case of ECIP projects, Mobile District does not provide specific energy conservation options, but relies on the A/E's expertise in conjunction with instructions of Chapter 18 to select promising options for investigation. In the early stages of design, the reviewers ensure the A/E has complied with his instructions regarding energy conservation.

SAS--Both methods are currently used.

SWF--Whether the designs are done in-house or contracted, the energy conservation options, if required, are supplied by the user through the DD 1391 and PDBs.

d. How important a role does the DD 1391 and PDB play during the development of a project?

MRO (elec)--Very important. 1391 provides the Corps with design criteria, scope, and funding constraints.

MRO (mech)--The 1391 and PDBs are very important because they describe what the user actually wants. Good 1391s and PDBs generate better designs.

NPS--Where these documents reference a preference by the base for a specific type of system, or energy source, they form the basis for not performing the energy conservation measures referenced in the A/E guide.

SAM--If the DD 1391 and the PDB are properly prepared, they are very useful in defining the project criteria. After A/E selection, project criteria are further developed during the prenegotiation meeting or predesign conference. With respect to energy conservation, it would seem that the criteria should be a goal, i.e., target energy budget, rather than a list of specific options for consideration. During the prenegotiation proceedings, if the A/E sees a list of specific options for consideration, he will allocate effort for investigation of each option and will incorporate that effort into his fee proposal. During design, if the reviewer(s) suggests an alternate approach inconsistent with the list of options to be investigated, the A/E's contract would have to be modified. There is also the possibility that effort could be wasted investigating some option(s) the A/E knows from experience will not pay off, but which he must document with calculations and narrative.

SAS--The 1391 plays a critical role in all projects because it contains mandatory limitations and restrictions which designers must satisfy. The 1391 and PDB do not play a large role in choosing energy systems and conservation methods because these are items subject to professional analysis.

SWF--The DD 1391 and PDBs are the most important documents in the development of a project. They include the scope of work, size and function of the facility, construction cost limitations, design features, etc. However, the energy conservation options indicated in DD 1391 and PDBs are always ambiguous in intention and requirements, and will often not be considered or not taken seriously by the designer unless specifically addressed during the predesign conference by the user.

2. PERCEIVED OR MEASURED RELEVANCE OF THE OPTIONS COMPARED WITH CURRENT DESIGN PRACTICE

a. How comfortable were you with the options provided? Would they be considered during design by designers?

MRO (elec)--All except 52-54. These items require more R&D and should be done on a case-by-case basis with user's consent.

MRO (mech)--Most of the items presented are very rarely considered for a normal design. Most could be mentally considered and rejected or accepted without doing a study.

NPS--The Seattle District's *Guide for Architects and Engineers* tasks the designers to produce an energy efficient design in several ways. The civil designer is required to provide studies on comparative energy conservation measures, but only where the civil portion of the design includes energy consuming processes. The architectural designer is required to provide an analysis on the building location, fenestration, overhangs, etc., in terms of energy impacts (among other impacts). The mechanical design is to include an economic comparison of alternative heating, ventilating, and air-conditioning systems, including fuel costs, in addition to other routine cost items. A computer simulation of three alternative building climate control systems to assist in the economic comparison may be required, and an energy budget calculation is required (unless specifically excluded). In addition, a requirement to provide data in the design analysis mentions energy saving features such as run-around coils, thermal wheels, and double bundle condensers. Additional energy saving ideas are referenced in the criteria index.

ORL--For the most part.

SAM--Subject to the reservations expressed in 1d above, the list of options provided is adequate for most projects. A prudent designer would consider the options relevant to a particular project and climatic zone, and would probably study additional variations within those options.

SAS--The criteria currently require that all reasonable alternatives be considered and that the most promising options be evaluated based on life cycle cost. Any designer who fails to do this is violating current Federal codes.

SWF--Options 15-19, 25, 30, 37, 42, 50, 51, 59-62 are considered design criteria of energy conservation. These design criteria are covered bv the *Architectural and Engineering Instructions, Design Criteria* [Office of the Chief of Engineers]; [Air Force Regulation] AFR 88-15, *Criteria and Standards for Air Force Construction*; various Army and Air Force [Engineer Technical Letters] ETLs; and the Corps of Engineeres Guide Specifications. These options will be automatically incorporated into each project, where applicable, by the designer whether they are listed in DD 1391 and PDBs or not. Options 4-6, 23, 48 are considered heating strategies of energy conservation. These heating strategies may only be cost effective for northern parts of the United States where heating is the predominant energy requirement. These options will not be considered for projects in the climate region covered by Fort Worth District where cooling is the predominant energy requirement. Options 1, 3, 7-9, 12-14, 20, 24, 26, 27, 29, 33, 34, 36, 38, 52, 58 are considered current design practice of energy conservation. These design practices are considered sound engineering practice and judgment, and/or cost effective, and will always be considered by the designer and incorporated into each project where practical and applicable, whether they are listed in DD 1391 and PDBs or not. Options 2, 10, 22, 40, 43, 49 are considered requested applications of energy conservation. These will be considered by the designer only when requested by the user through DD 1391 and PDBs because they tend not to be cost effective and/or create maintenance or operating problems as experienced by designers in this region. Options 11, 21, 28, 53-55 are considered general applications of energy conservation. These will be considered by the designer when requested by the user through DD 1391 and PDBs because the cost effectiveness of these options is based mostly on the operating characteristics of the facility, and the user may have a better [idea] as to whether the operating characteristics of the facility would justify the installation of these options. Options 31, 32, 35, 39, 41, 44-47, 56, 57 are considered specific applications of energy conservation. These options will be considered by the designer when the building type with specific HVAC requirements, large heat generating equipment, central power plant, etc., or located in specific climatic regions warrants the consideration of these options and/or [are] requested by the user through DD 1391 and PDBs.

b. If the set of energy conservation options are kept up-to-date, what techniques will be necessary to encourage full use of these options during the design process?

MRO (elec)--1. Placed in DD 1391. 2. A/E instructions to designers. 3. District A/E manuals.

MRO (mech)--The main problem would be the ease of evaluating the options. Most would require too much time to properly evaluate.

NPS--For Seattle District, the best method to implement additional energy options seems to be to include them in the A/E guide. The specific options to consider then need to be mentioned in the Statement of Work (SOW) to the designer, or possibly in the project book or the DD 1391. Alternatively, the options in the A/E guide could be set up so that the designer was directed to consider them unless the SOW specifically excluded them.

ORL--Manual update? Computer update? Where are options kept? Unclear.

SAM--The best way to encourage full use, i.e., evaluation of energy conservation options, is to follow a policy of requiring the A/E to produce energy-efficient designs. Mobile District does this through the use of the A/E design manual as mentioned in 1c. Mobile architects and engineers are all provided with a copy of the A/E design manual, which they use in conjunction with the project criteria to review design submittals.

SAS--A good way to improve compliance with current Federal requirements would be to add appropriate notes to all standard and definitive design plans stating that energy analysis is required for all site adaptations.

SPK--A set of energy conservation options for our Architect/Engineers would require a great deal of effort by each District to enforce strict compliance. It would be expensive and foolish to request every designer to repeat some of the energy options.

SWF--In the categories of requested, general, and specific application of energy conservation mentioned above, more specific facility operating requirements, characteristics and procedures, more accurate equipment operating data and schedule, etc., data and information that are required for the designer to do the energy saving study and life cycle cost analysis should be identified, listed, and emphasized in order to encourage the designer to study the options.

c. Are there any constraints on the options that should be noted to future designers? What improvements should be made?

MRO (elec)--Yes. Customer satisfaction. Design must be practical and fulfill user's needs. Options 52-54 should be done on a case-by-case basis.

MRO (mech)--Some guidance should be provided as to when an option should even be considered. A checklist could be used to assure that a particular item was at least considered.

NPS--It is important to note that many of the options presented for energy savings are normally considered to be good design practice. As such, the energy study implementation is now required as part of the design and quality control/ quality assurance process. These should not be listed separately in the DD 1391 or PDB as an energy option since to do so could cause an increase in the design cost even though little or no additional work is required, but simply because of the additional line item in the description of the work.

ORL--Only sound engineering judgment should be used.

SAM--The only constraints recommended for the proposed energy conservation options are those expressed above. No improvements are suggested at this time.

SAS--Only that all reasonable energy systems and alternatives must be considered as required by current Federal laws and codes.

3. RECOMMENDATIONS FOR FUTURE TESTING OR BROADER APPLICATION

a. Do you feel that it was worthwhile for you to study these options?

MRO (elec)--Yes.

MRO (mech)--Only if it becomes mandatory to evaluate all of the options that could be considered on a job.

NPS--Yes, input generated should help USACERL.

ORL--Yes.

SAM--The study of these options was worthwhile.

SAS--Yes.

SWF--It is recommended that only the most appropriate options for the facility type in the specific climatic region should be listed in DD 1391 and studied by the designer. The options grouped under category of design criteria should be identified and distinguished in DD 1391 from other options so that they can be used as a design check list by the designer.

b. Would you participate in future field tests of these options?

MRO (elec)--Yes. Design funds and time would have to be provided.

MRO (mech)--Yes.

NPS--This would have to be decided on a case-by-case basis.

ORL--Yes.

SAM--We would participate in future field tests of these options.

SAS--Yes, as scheduling/funds allow.

SWF--Some of the options for the specific application, such as the heat recovery system, air-to-air heat exchanger, oxygen in combustion air monitored, etc., involve various assumptions such as amount of heat loss to be recovered from equipment, facility operating schedule vs. heat recovery equipment operating schedule, equipment operating efficiency, etc., in order to do the study. Although the results of the study may indicate that the options are cost effective, it is often doubted that the actual installation may produce the energy saving as anticipated. Future field testing to validate the effectiveness of these options is warranted and would certainly be participated [in] by this agency.

SECTION 2

This section contained the respondents' evaluations of the 62 options' applicability in 37 projects. The results, which are summarized in the text, are not duplicated here due to their length.

SECTION 3

1. AN EVENTUAL GOAL IS TO INTEGRATE AN ENERGY PLANNING MODULE INTO THE DD 1391 PROCESSOR. THE MODULE WILL PROVIDE A LIST OF OPTIONS TO BE CONSIDERED IN THE DESIGN OF A NEW FACILITY. WHAT SHOULD BE THE MAXIMUM NUMBER OF OPTIONS SUPPLIED BY THE MODULE?

   MRO (elec)--All practical options that will provide a practical and useful facility and yet fulfill all the needs of the end USER! Work should be done as feasibility studies and part of the design. Normal design schedules and funds do not permit options to be studied. Additional options that can be considered include: 1) area switching, 2) bi-level switching, 3) three way switching, 4) use energy efficient motors, 5) use power factor correctors for motors over 25 hp, 6) EMCS.

   MRO (mech)--4 to 6, provided they would not all have to be economically evaluated. Active solar systems can also be considered as an additional option.

   MRO (site)--The options considered will probably be determined by the designer regardless of what the DD 1391 states, unless the DD 1391 processor can determine which option has a good potential for a low life cycle cost analysis for the type of building considered.

   SAM--The number of options to be supplied should be kept to a minimum, but the actual number would be determined by the type of facility. However, the list of options should be considered a guide. The designer should not be restricted to study only the options on the list; nor should he be required to formally study all options on the list. He should submit format studies only for those options which he determines from his experience are worthwhile investigating for the particular facility.

   SAS--All feasible alternatives should be considered by the Designers. No maximum should be arbitrarily set by the Planner. There should not be a maximum. This contradicts regulations which require that all feasible alternatives be considered and the most promising options be evaluated based on Life Cycle Cost. This "consideration" of alternatives should be done by the Designer, not by the Planner. The Planner should provide information the Designer might need to make decisions, but should not specify the alternatives.

   SWF--Only the options considered important to the facility type in a specific climatic region. High ranking options (7 or 8 and above in importance) should be supplied by the module.

2. MISCELLANEOUS COMMENTS, SUGGESTIONS, ETC.

   MRO (elec)--Avoid a mandated approach with strict detailed requirements that in some situations will simply be impossible to fulfill--rather, provide general guidance or goals which can be met with a variety of optional techniques which would not have to be implemented in exactly the same fashion in every project.

MRO (site)--Most DD 1391 preparers do not presently have the time or training to consider numerous energy saving options. The energy pianning module would have to be designed for such a background if the DD 1391 preparer is to use it.

SWF--The options grouped in category of design criteria should be distinguished and identified in the DD 1391 so that the designer can use it as a design check list and not waste time doing a study.

APPENDIX C:

DESCRIPTION OF FACILITIES EVALUATED

Fort Worth District

Physical Fitness Center, Fort Bliss, TX

(Physical fitness center consisting of gymnasium, handball court, exercise room, sauna room, etc.)
21,500 SF, 740-674*
21,500 SF - Physical Fitness Center

Child Development and Religious Education Center, Fort Hood, TX

(Support facilities for child care center, conducting of religious services and religious education)
55,925 SF, 740-14
22,725 SF - Child Development Center
21,000 SF - Religious Education Center
10,200 SF - Post Chapel

Tactical Equipment Shop, Fort Hood, TX

(Maintenance complex for activation of Patriot missile battalion)
32,500 SF, 214-20
31,000 SF - Maintenance Bay
1,500 SF - Office

Family Housing 583 Units, Fort Polk, LA

(543 junior enlisted and 40 company grade officer family housing units)
578,850 SF, 711-15
578,850 SF - Family Housing

Military Personnel Support Center, Dyess AFB, TX

(Support facilities for personnel actions, social actions, and family services. Can be used as temporary fallout shelter.)
54,000 SF, 610-128
44,000 SF - Administration
10,000 SF - Classroom

Recreation Center, Goodfellow AFB, TX

(Recreation complex consisting of recreation center, ballroom, music room, supply, and kitchen area)
25,300 SF, 740-316
20,000 SF - Recreation Center
4,200 SF - Supply Room
1,100 SF - Kitchen

*Army facility category code per AR 415-28.

Aircraft Maintenance Facility, Holloman AFB, NM
(Hangar for aircraft maintenance and supporting facilities)
61,500 SF, 211-152
47,500 SF - Hangar
14,000 SF - Office

Logistic Complex, Lackland AFB, TX
(To provide standard Air Force Base supply storage and house commander for resources management and his staff)
144,000 SF, 442-758
120,000 SF - Warehouse
24,000 SF - Office Area

Unaccompanied Officer Personnel Housing (UOPH), Randolph AFB, TX
(80 unaccompanied officers living units)
52,800 SF, 724-417
52,800 SF - Motel-Type Rooms

Louisville District

Battalion Headquarters, Fort Campbell, KY
12,326 SF, 14183
7,510 SF - Administrative Offices
3,391 SF - Instructional Classrooms
1,425 SF - Mechanical and Other

Guest House, Fort Benjamin Harrison, IN
9,924 SF, 74032
6,182 SF - 16 Lodging Units
1,679 SF - Mechanical and Circulation
618 SF - Support Facilities

Flight Simulator, Fort Campbell, KY
31,814 SF, 171-12
11,917 SF - Simulator Facility
10,650 SF - Mechanical, Circulation, Support Storage
9,247 SF - Administrative and Instructional Facility

Child Development Center, Rock Island Arsenal, IL
5,800 SF, 740-14
4,524 SF - Development Area
784 SF - Administrative
479 SF - Mechanical/Other

Six Gymnasium Additions, Fort Knox, KY
41,794 SF, 730-48
36,994 SF - Gyms and Showers
3,840 SF - Mechanical and Other
900 SF - Office

Mobile District

Unaccompanied Enlisted Quarters, Fort McClellan, AL
(Transient housing for unaccompanied enlisted personnel attending schools)
325,000 SF, 721-20
300,000 SF - Barracks
25,000 SF - Administrative Space

Consolidated Support Maintenance Facility, Fort McClellan, AL
(General-purpose maintenance shop)
96,232 SF, 218-85
74,816 SF - Shop Space
16,925 SF - Storage, Electrical & Mechanical Space
4,491 SF - Administrative Space

Polygraph Training Facility, Fort McClellan, AL
(Classroom and laboratory polygraph training)
21,153 SF, 171-30
17,855 SF - Training
2,878 SF - Administrative
420 SF - Mechanical

ADP Building, Cairnes AAF, Fort Rucker, AL
(Computer operations)
3,000 SF, 311-90
1,300 SF - Ancillary Areas
980 SF - Telemetry Room
720 SF - Computer Room

Flight Simulator Building AH-1S, Fort Rucker, AL
(Flight simulation training)
16,645 SF, 171-12
9,093 SF - Simulators and Trainers
4,119 SF - Mechanical
3,433 SF - Administration, Briefing, Entrances

Classrooms, Fort Rucker, AL
(Classrooms for U.S. Army Aviation School)
53,814 SF, 171-20
24,832 SF - Classrooms and Offices
18,026 SF - Break Areas, Corridors, Stairwells
10,956 SF - Storage, Mechanical, Projection Rooms, Toilets

Unaccompanied Officers Quarters, Fort Rucker, AL
(Unaccompanied officers quarters)
97,000 SF, 724-15
66,000 SF - Quarters
31,000 SF - Circulation, Service and Public Spaces

Millimeter Microwave Simulation Facility, Redstone Arsenal, AL
(Research and development facility)
112,211 SF, 310-90
51,152 SF - Circulation, Mechanical, Electrical, Other
40,515 SF - Simulator Chambers
20,544 SF - Support Spaces

Redstone Scientific Information Center, Redstone Arsenal, AL
(Library addition, high density storage)
9,595 SF, 310-90
8,520 SF - High-Density Storage Area
1,024 SF - Mechanical Equipment Room
51 SF - Vestibule

Systems Engineering Laboratory Addition, Redstone Arsenal, AL
(Research and development facility)
181,560 SF, 310-90
124,515 SF - Laboratories and Shops
43,831 SF - Corridors, Stairs, Mech/Elec, Toilets
13,214 SF - Offices, Theater, Lobby

Omaha District

Field Training Detachment, Whiteman AFB, MO
(Provide technical maintenance training on aircraft engines, structures and electronic components)
34,000 SF, 171-618
16,000 SF - Training Classrooms
10,000 SF - Building Support
8,000 SF - Administrative

Munitions Maintenance Squadron (MMS) Facility, Whiteman AFB, MO
(Combination administrative, munitions control, and training of munitions personnel)
37,000 SF, 215-552
19,000 SF - Training Classrooms
10,000 SF - Building Support
6,000 SF - Munitions Control
2,000 SF - Administrative

SAC Wing Headquarters, Whiteman AFB, MO
30,500 SF, 610-249
16,000 SF - Administrative
10,000 SF - Building Support
4,000 SF - Command and Control Center

FTD Trainer Facility, Whiteman AFB, MO
(Facility will be used for aircraft maintenance and operational training needs of the Air Force)
23,200 SF - Classrooms
9,600 SF - Training Area

MMS Load Trainer Facility, Whiteman AFB, MO
(Facility will be used for aircraft maintenance and operational training needs of the Air Force)
12,000 SF - Classrooms
18,700 SF - Training Area

Aircraft Maintenance Management Facility, McConnell AFB, KS
(Administration facility)
20,000 SF, 610-129
18,250 SF - Administrative
1,000 SF - Mechanical
750 SF - Restrooms

Avionics Maintenance Facility, Ellsworth AFB, SD
(Electronic equipment repair shops and administrative space)
35,000 SF, 217-712
24,000 SF - Electronic Repair Shop
8,000 SF - Administrative Space
3,000 SF - Mechanical & Electrical

Vehicle Maintenance Facility, Fort Carson, CO
(Vehicle maintenance facility for Army vehicles)
68,000 SF, 214
26,000 SF - Repair Bays
23,000 SF - Administrative
9,400 SF - Warehouse

Savannah District

Advanced Combat Rifle Range, Fort Benning, GA
800 SF - Operations/Storage
288 SF - Latrines
228 SF - Control Tower
120 SF - Ammo Building

Tactical Equipment Maintenance Complex, Fort Bragg, NC
35,840 SF, 210
35,840 SF - Maintenance Shop
1,550 SF - Cartographic
268 SF - Sentry Buildings
268 SF - Fuel Houses

Engineering Test Facility, Robins AFB, GA
55,000 SF, 217-735
30,527 SF - Test/Laboratories
8,696 SF - Office
4,360 SF - Shop

Seattle District

Naval/Marine Corps Reserve Center Training Building, Gowen Field, Boise, ID
27,000 SF, 171-15
10,000 SF - Administration
10,000 SF - Classroom/Assembly
7,000 SF - Storage/Lockers/Restrooms

Consolidated Squadron Operations Facility, McChord AFB, WA
48,000 SF, 141-753
40,000 SF - Assembly/Administration & Classroom
5,000 SF - Mechanical
3,000 SF - Circulation

APPENDIX D:

VERBATIM PARTICIPANT COMMENTS ABOUT THE ENERGY CONSERVATION OPTIONS

In this part of the test, participants were asked if the options are applicable. Responses are given below for each option.

1. Building shape and orientation

NPS--Yes. The user generally specifies building location and orientation, in terms of where the "front" door is.

SAM--Flexibility is limited by [the] relationship of [the] facility to existing structures and amount of space available onsite.

SPK--This option is not routinely done in the District unless the A/E has been given specific [guidance] and/or assistance. This option is especially difficult to change, based on the desires for a specific site location and orientation by the user.

2. Earth berming

NPS--Yes.

ORL--Earth berming [is] not allowed by post policy.

SAM--Flexibility is limited by [the] relationship of [the] facility to existing structures and amount of space available onsite.

SPK--This option is not routinely done in the District unless the A/E has been given specific [guidance] and/or assistance.

3. Landscaping

NPS--No. Should receive more emphasis in military design.

SAM--Flexibility is limited by [the] relationship of [the] facility to existing structures and amount of space available onsite.

SPK--This option is not routinely done in the District unless the A/E has been given specific [guidance] and/or assistance.

4. Direct gain glazing (direct solar gain)

NPS--No. Problems with direct solar gain include glare, furniture and finish bleaching, and the restrictions on interior layout. This option has been found to not offer significant benefits which would offset the associated problems.

SAM--Not applicable to windowless high-security buildings.

5. Indirect gain glazing (indirect solar gain)

NPS--No. Problems include high first cost and the fact that the required thermal storage wall restricts the available "views" outside. Not considered a useful option in the majority of military design.

SAM--Not applicable to windowless high-security buildings.

6. Heat-absorbent glazing

NPS--Yes. This has been used successfully on numerous designs and also helps problem of fading.

SAM--Not applicable to windowless high-security buildings.

7. Daylighting

NPS--Yes. This should receive more attention. The user should be educated to accept restrictions on building layouts to accommodate this option.

SAM--Not applicable to windowless high-security buildings.

8. Increased surface reflectance

MRO--At a Whiteman AFB, MO, project, increased surface reflectance would cause a problem for pilots.

NPS--No. Colors and textures are generally restricted by the user. Installations have overall "esthetic themes" which restrict color choices. This should, however, be considered and incorporated into the basewide schemes.

9. Fixed exterior shading

NPS--Yes.

10. Seasonal window shading

NPS--No. This is not acceptable to the user due to maintenance requirements. Interior devices have limited usefulness because the heat has already gotten "into" the building. This option requires an inordinate amount of maintenance, and is not popular with the building user. In operation, there is often a lack of controllability which minimizes effectiveness.

SAM--Not applicable to windowless high-security buildings.

SWF--Seasonal window shading is not used here due to difficulty to maintain and difficulty to fit into the architectural scheme for the facility type.

11. Skylights

NPS--Yes. Criteria restrict use of glazing and skylights. This option complements daylighting, and more attention should be paid to use of skylights.

SAM--Not applicable to windowless high-security buildings.

12. Natural ventilation

NPS--No. This should be considered by designers, but also by the user where requests are made to convert existing open space into office type cubicles, thus unfortunately limiting natural air circulation.

SAM--This requires an operable window. This option cannot be used for a polygraph training facility where most of the space in the facility is unglazed for security. Not applicable to windowless high-security buildings.

SAM--Unconditioned outside air should not be introduced into library stack areas due to strict humidity requirements.

13. Zoned lighting systems

NPS--Yes. Lighting is zoned now as a matter of policy rather than for cost or energy saving. The low cost of electricity in this area reduces savings and zoning increases problems from over and under illumination. Criteria dictate low light levels, which further reduce savings.

14. Task-specific illumination level and equipment

NPS--No. Often the designer does not know what the task will be, therefore, task-specific design is not possible. Building use changes frequently, and task-specific design must have fast payback, and must be easy to move, modify, or remove. This information must be supplied by the user.

15. Double glazing

NPS--Yes

SAM--Not applicable to windowless high-security buildings.

16. Minimized glass area

NPS--Yes.

SAM--Not applicable to windowless high-security buildings.

17. Optimized insulation level

NPS--No. Defined by criteria. (New criteria are revising this. In future optimization of insulation, it will be very important.)

18. Infiltration control

NPS--Yes. This merits closer attention on remodeling work than new construction.

SAM--This is a practice that any prudent designer (or anyone who follows Corps of Engineer guidelines) will employ wherever they are applicable.

19. Vapor barrier

NPS--Yes. This comes under the heading of "good design" rather than a specific energy measure.

20. Air barrier curtain

NPS--Yes. Limited application, i.e., loading docks, etc.

SAM--Air barrier curtains do not appear to be applicable to motel-style unaccompanied enlisted housing or any facility with no large and/or frequently operated doors.

21. Air destratification

NPS--Yes.

22. Increased ceiling height

NPS--No. Usually, ceiling height is determined by use of the space. Additional expense would seem to make this infeasible in all cases.

SWF--Increased ceiling height to reduce cooling loads by allowing warm air to rise above the level occupied is not applicable here due to the increased construction first cost, increased perimeter area with increased heating and cooling loss, and is also in conflict with the strategy of air destratification during the heating season. This strategy is mainly for facilities in climatic regions requiring cooling energy only.

23. Moveable insulation

NPS--High first cost and maintenance cost. User does not like this option. Additional expense would seem to make this infeasible in all cases.

24. Thermal breaks

NPS--Yes. This is routinely done as a part of "good design."

25. Vented roof or plenum

NPS--Yes. Routine part of good design.

26. Group heat-producing equipment

NPS--No. Generally this equipment is located by the user. In the case of office equipment, this may lower user efficiency (in terms of manhours to accomplish a task).

SAM--Not a relevant option if facility has no equipment with significant heat loads.

27. Airlock entries

NPS--Yes.

28. Duty cycling

NPS--No. When EMCS is available, this is addressed.

SAM--Duty cycling does not seem appropriate for study for any project during the design phase. Duty cycling is more appropriately investigated during EMCS studies.

SPK--This program is part of the base-wide EMCS system, but has not been tried on individual systems in the District. We don't believe the advantages or disadvantages can be actually measured.

SWF--Duty cycling is one option that the designer has less input in because it is mainly controlled by the user of the facility, and this is normally done through EMCS based on facility priority and equipment constraints as determined by the user.

29. Variable air volume system

NPS--Yes. This is applicable to certain situations, and not to others. It is an engineering decision rather than an energy one.

SAM--Not applicable to computer facilities that require constant rates of supply and exhaust air to maintain a specific level of building pressurization.

SPK--This energy savings option is routinely run on most projects. We are happy to see the recent change to [Department of Defense] DOD [criteria] which allows us to cite previous designs to reduce cost and time spent on each project.

30. Decreased supply and makeup air

NPS--No. This is set by criteria and good design practice. In general, we are operating on the low end of the scale now. Criteria already put levels of outside air at or below the generally accepted limits. A further decrease seems ill-advised.

SAM--This is a practice that any prudent designer (or anyone who follows Corps of Engineer guidelines) will employ wherever applicable.

SPK--The District does consider this in design, but we do not reduce air quantities below 3 or 4 air changes per hour.

31. Air-to-air heat exchanger

NPS--Yes. This is applicable to certain situations, and not to others. It is an engineering decision rather than an energy one.

SAM--Not feasible if facility does not have large quantities of exhaust and makeup air that would make such heat recovery schemes attractive.

SPK--The District has not done any design work in this area.

32. Latent heat exchange pipe system

NPS--Yes. This is applicable to certain situations, and not to others. It is an engineering decision rather than an energy one.

SAM--Not feasible if facility does not have large quantities of exhaust and makeup air that would make such heat recovery schemes attractive.

SPK--This system is not done routinely but was studied recently for a project near Hill AFB, Utah, at an elevation of 7,000 ft. System proved not cost effective and was too large for the building. First cost of only the heat pipe was $20,000. System chosen was a computer room unit with a dry cooler option whereby the cooler only was used for conditioning the space in lieu of using the refrigeration cycle. Total cost of system was less than $20,000. Lots of temperatures below 50 degrees F are required, though, to make it pay.

33. Task-specific temperature, humidity level

NPS--Yes, [but] situations where this applies are infrequent.

SAM--This is a practice that any prudent designer (or anyone who follows Corps of Engineer guidelines) will employ wherever applicable.

SPK--The District has not done any design work in this area.

34. Zoned air handling

NPS--Yes. This is considered good design practice, i.e., not requiring justification based on energy saving.

SAM--This is a practice that any prudent designer (or anyone who follows Corps of Engineer guidelines) will employ wherever applicable.

SPK--The District discourages the use of multiple units because these can increase maintenance costs for the user.

35. Spot cooling and heating

NPS--Yes.

SPK--The District does encourage its usage in factory-type buildings or large warehouses where there are some small open offices that are authorized [for] air-conditioning.

36. Minimized resistance in duct and pipe

NPS--Yes. Keeping velocities within "normal" limits is considered good design practice; however, some conflicts do arise from duct size vs. available space. This is especially true with mechanical ventilation systems for comfort cooling, where the air volumes are large.

SAM--This is a practice that any prudent designer (or anyone who follows Corps of Engineer guidelines) will employ wherever applicable.

SPK--The District is not clear as to what would be done to implement this item since sizing now is per TMs and ASHRAE criteria. We use TRANE's duct sizing program for some projects.

37. Insulated ducts and pipes

NPS--Yes. Minimums are dictated by criteria. Proper use of insulation is considered good design practice.

SAM--This is a practice that any prudent designer (or anyone who follows Corps of Engineer guidelines) will employ wherever applicable.

SPK--The District does not recommend this be studied on a routine basis. The option should not be studied unless directed to do so, since the current specifications require insulation thickness based on "K" values.

38. Variable water flow rates

NPS--Yes. Flow restrictors in fixtures are dictated by criteria to prevent overuse of water. Buildings tall enough to require boosters are quite rare in CENPS design experience.

SPK--Studies are not done on a routine basis, but a recent one did prove cost effective based on [the] Life Cycle Cost program. [That] system was for a large building complex, using chilled water with 1,500 hp pumps.

39. Direct evaporative cooling

MRO--At a McConnell AFB, KS, project, the summer wet bulb temperature was too high to effectively use evaporative cooling. At an Ellsworth AFB, SD, project, electronic test equipment requirement dictated the use of mechanical cooling.

NPS--Yes. Until the revisions of DOD 4270.1-M, there were restrictions on the use of evaporative coolers; the future use is uncertain.

SAM--Evaporative cooling is not a viable option for the southeastern United States where wet bulb temperatures are generally high.

SPK--Direct and indirect cooling studies are done by the District for Utah, California, Nevada, and Arizona when the user requests that multistage cooling be provided in lieu of air-conditioning. Studies show that delta T is about 20 degrees with leaving air temperatures around 60 degrees F. However, unit [the evaporative cooler] is twice as large as a comparable A/C unit and must be located out of doors. Maintenance cost over the 25 year period is unknown, and we cannot guarantee the users that the outside design dry bulbs and wet bulbs will always give them a comfortable environment.

40. Indirect evaporative cooling

MRO--See no. 39.

NPS--Yes.

SAM--Evaporative cooling is not a viable option for the southeastern United States where wet bulb temperatures are generally high.

SPK--See no. 39.

41. Exterior vented heat-producing equipment

NPS--Yes. Applicable to large, fixed equipment, such as kitchens. Heat recovery is used in these cases also. Any analysis of this option would have to recognize that the building use changes repeatedly during the life of the building, and the system would have to pay itself off in less than the life of the equipment.

SAM--This is a practice that any prudent designer (or anyone who follows Corps of Engineer guidelines) will employ wherever applicable.

SPK--Considered occasionally by the A/E but not always when it should be.

42. Dry-bulb temperature economy cooling

NPS--Yes. Required by criteria.

SPK--This is normally included in the design. However, in some warm areas of the country, such as Yuma, AZ, where the night temperatures are high, it has proved to be not cost effective.

43. Reuse of exhaust air

MRO--Exhaust from restroom and vehicle maintenance areas would not be reused.

NPS--This could be misapplied quite easily. It should only be part of an engineered combustion system, probably in a central heat plan.

SAM--Boiler-related options are not applicable if facility is served by a central steam plant.

SPK--The District has not done any work in this area.

44. Electronic filter

NPS--No. Military design is at (or below) minimum outside air now. This option should be examined in view of recent studies of health effects of "tight" buildings.

SPK--The District has not done any work in this area.

SWF--Electronic filters allow the greater use of return air and minimize the amount of outside air. Reuse of return air is generally prohibited in hospital facilities by various building codes and criteria, and the reuse of return air in kitchens is usually not cost effective because cooling is generally not provided, and the heating requirement is minimum in this climatic region where cooling is the predominant energy usage.

45. Heat recovery chiller

NPS--Yes.

SPK--Could be considered for heating of domestic hot water for barracks, but not tried in this District. Economic advantage unknown.

46. Oxygen in boiler combustion air monitored

MRO--Oxygen trim for small boilers is not economically feasible.

NPS--Yes. This is preferred over option 43.

SAM--Boiler-related options are not applicable if facility is served by a central steam plant.

SPK--Studies not required, since most large boilers specify this type of system.

47. Boiler inlet water preheated with flue gas

MRO--At an Ellsworth AFB, SD, project, the boiler inlet water is minimal.

NPS--Yes.

SAM--Boiler-related options are not applicable if facility is served by a central steam plant.

SPK--Inlet water with flue gas. This system has not been tried in the District.

48. Humidification of supply air

NPS--No.

SAM--This is a practice that any prudent designer (or anyone who follows Corps of Engineer guidelines) will employ wherever applicable.

SPK--Economics unknown. This has not been tried in the District.

49. Runaround coil distribution system

NPS--Yes.

SAM--Not feasible if facility does not have large quantities of exhaust and makeup air that would make such heat recovery schemes attractive.

SPK--This has possible application in automotive maintenance shops that require 1.5 cfm/sq ft ventilation per ASHRAE criteria. Economics currently being studied for "in-house" design at Dugway, Utah.

50. Minimize light fixtures

MRO--This is part of standard design practice balanced against considerations of funding (first cost), the functional requirements of the application, and regulations restricting proprietary type design.

NPS--Yes. Considered a part of good design.

SAM--This is a practice that any prudent designer (or anyone who follows Corps of Engineer guidelines) will employ wherever applicable.

51. Efficient fixtures and lamps

MRO--This is part of standard design practice balanced against considerations of funding (first cost), the functional requirements of the application, and regulations restricting proprietary type design.

NPS--Yes. Fort Lewis requests metal halide lamps instead of high pressure sodium in many industrial facilities to help color vision. (Manuals using color were difficult to read.)

SAM--This is a practice that any prudent designer (or anyone who follows Corps of Engineer guidelines) will employ wherever applicable.

52. Efficient artificial lights compatible with daylight

MRO--This option requires point-to-point calculations and special design consideration. Omaha District has had problems with special applications involving daylighting and indirect lighting. This type of lighting needs to be designed very conservatively (considering the many indefinite aspects) and materials, equipment, and/or performance have to be well defined. These options could be applied to buildings with large window areas in warmer climates. In other words, the architectural layout and climate would play a very important part in this option.

NPS--No. All buildings are designed to allow 24-hour per day use. Occupant can turn off lights as required.

SAM--This is a practice that any prudent designer (or anyone who follows Corps of Engineer guidelines) will employ wherever applicable.

53. Timers for lights

NPS--Usually only at the request of the user. Sometimes this is done by EMCS. This option is not generally acceptable. Buildings with small rooms and varying occupancies would require many timers. When timers become a nuisance by turning out lights during a training class for example, the occupants will jumper the timer, negating its effectiveness.

SAM--This is a practice that any prudent designer (or anyone who follows Corps of Engineer guidelines) will employ wherever applicable.

54. Daylight responsive lighting controls

MRO--See no. 52.

NPS--Yes. Outside only.

SAM--This type of control has not always proved reliable and cost effective. In many types of facilities, these would not pay back.

55. Motion sensitive lighting control

MRO--See no. 52. It is recommended that this option emphasize passive infrared types of motion sensing, and avoid ultrasonic generating types which could interfere with other systems such as intrusion detection, and could have health and environmental impacts.

NPS--No. This option is not generally acceptable. In most uses, a motion sensor would not be cost effective with the low electric rates in the Pacific Northwest. These devices would have to be coordinated with the HVAC design in cases where lighting is assumed to provide some of the heat in winter.

SAM--This type of control has not always proved reliable and cost effective. In many types of facilities, these would not pay back.

56. Heat pump water heater

NPS--No.

SPK-- The District has not done any work in this area. It appears that electrical cost would have to be exceptionally high to offset first cost.

57. Heat recovery

NPS--Yes.

SPK--The District has not done any of this work.

58. Point-of-use water heaters

NPS--Yes.

SAM--These would not be economical for motel-style unaccompanied enlisted housing.

SPK--The District advocates this on many projects, where there are small toilet rooms remote from the main toilet rooms. It is used frequently on large warehouse type facilities.

59. Optimum water pipe and tank insulation

NPS--Yes. Criteria usually set thickness of insulation inside buildings. This is important on outside heat distribution systems.

SAM--This is a practice that any prudent designer (or anyone who follows Corps of Engineer guidelines) will employ wherever applicable.

SPK--The District does not believe that this option should be studied frequently or at all. If done, it should be done only once with revisions made to the insulation guide spec, if applicable.

60. EMCS

NPS--Yes.

SAM--Typical EMCS energy conservation programs would not be appropriate for a computer facility with critical HVAC requirements.

61. Reduced water supply temperature

NPS--No. Set by criteria (rather low). This should be reviewed in view of the possibility that lower temperatures allow microorganisms to grow.

SAM--This is a practice that any prudent designer (or anyone who follows Corps of Engineer guidelines) will employ wherever applicable.

62. Flow restrictions and water conserving fixtures

NPS--No. Now required by criteria and CEGS 15400.

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